Summary

Preliminary Feasibility Studies
for Great Lakes Connecting Channels
and Harbors Study

July 1982

US Army Corps
of Engineers
Detroit District

SUMMARY

OF

PRELIMINARY FEASIBILITY STUDIES

FOR

GREAT LAKES CONNECTING CHANNELS

AND HARBORS STUDY

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SYLLABUS

The Great Lakes - St. Lawrence Seaway commercial navigation system serves the heartland of the United States and Canada providing a minimum 25.5 foot safe vessel draft at low water datum. It is anticipated that unless modifications are made to the existing navigation system, some amount of waterborne commerce would not be able to be serviced in the future.

The study is to determine the feasibility of further commercial navigation improvements to the connecting channels, locks, and harbors on the upper four Great Lakes, and the extent of any Federal interest.

Preliminary feasibility studies have been completed.

In response to the commercial navigation problems, needs, and opportunities, several alternative structural plans were evaluated.

. deepening the connecting channels and harbors to provide greater draft on a system-wide basis

. installing a new lock at the lock facilities at Sault Ste. Marie, Michigan

. deepening the upper St. Marys River and three Lake Superior commercial harbors to optimize the availability of maximum draft during periods of high water on the lower system

. installing an alternate canal across Michigan's Upper Peninsula between Lakes Superior and Michigan

A non-structural plan (i.e. increased traffic control at the Soo Locks on the St. Marys River) and a No Action Plan were also evaluated.

Based on the analysis to date, a second large lock to accommodate the existing and projected fleet at the existing 25.5 foot vessel draft is economically justified. There is additional justification for a second large lock on the basis of National Defense and to reduce the risk of dependency of 25 vessels of the existing fleet which are solely dedicated to the operation of the existing Poe Lock. This plan maximizes net benefits and is the National Economic Development Plan warranting further detailed study. Total first costs for the lock are estimated at $170,000,000 (October 1981 price levels). Average annual costs are estimated at $15,849,000. Average annual benefits at 7 5/8% are estimated at $86,500,000. The resultant benefit-to-cost ratio is 5.46. This plan is further optimized by the inclusion of a non-structural measure(i.e. increased traffic control) which is both independently and incrementally justified.

Further system-wide deepening and an alternate canal across Michigan's Upper Peninsula are economically and environmentally infeasible at this time.

Deepening the upper St. Marys River and three Lake Superior harbors, modifying seven harbors to accommodate 1,000 foot by 105 foot vessels at the existing 25.5 foot draft, and a port-to-port analysis of Lake Michigan harbors that could benefit from additional modifications beyond the existing 25.5 foot draft system warrant further detailed study for feasibility.

While the final form of the proposed Administration's user fee and full cost recovery policies for commercial navigation improvements have yet to be determined, potential users/sponsors and affected States support continuation of the detailed studies.

The study is continuing into the detailed feasibility stage. The Final Feasibility Report and Environmental Impact Statement are scheduled for completion in September 1985.

SUMMARY
OF
PRELIMINARY FEASIBILITY STUDIES
FOR
GREAT LAKES CONNECTING CHANNELS
AND HARBORS STUDY

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SECTION I

THE STUDY AND REPORT

The Great Lakes-St. Lawrence Seaway commercial navigation system serves the heartland of two nations and the midcontinent of North America. The present system provides a minimum vessel draft at low water datum of 25.5 feet. During the past years, several significant advancements in design have resulted in improved maneuverability of new Great Lakes vessels. This report presents the evaluation of the economic, social, environmental, institutional and technical feasibility for making further commercial navigation system modifications at harbors, connecting channels and locks on the upper four Great Lakes.

PURPOSE AND AUTHORITY

Authorized by two resolutions of the Senate Committee on Public Works in 1969 and 1976, the purpose of the study is to determine the advisability of further improvements in the Great Lakes Connecting Channels and Harbors in the interest of present and prospective deep-draft commerce including the advisability of providing additional lockage facilities and increased capacity at the St. Marys Falls Canal at Sault Ste. Marie, Michigan (Soo).

SCOPE OF THE STUDY

The study includes the U.S. deep-draft harbors on the upper four Great Lakes and the connecting channels between Lakes Superior and Huron (St. Marys River); and Lakes Huron and Erie (St. Clair River - Lake St. Clair - Detroit River) upstream from the Welland Canal (see Figure 1). The Welland Canal, Lake Ontario, and the St. Lawrence River are not within the scope of this study; however, an economic model of the entire Great Lakes-St. Lawrence Seaway System has been developed to account for system-wide domestic and foreign shipping.

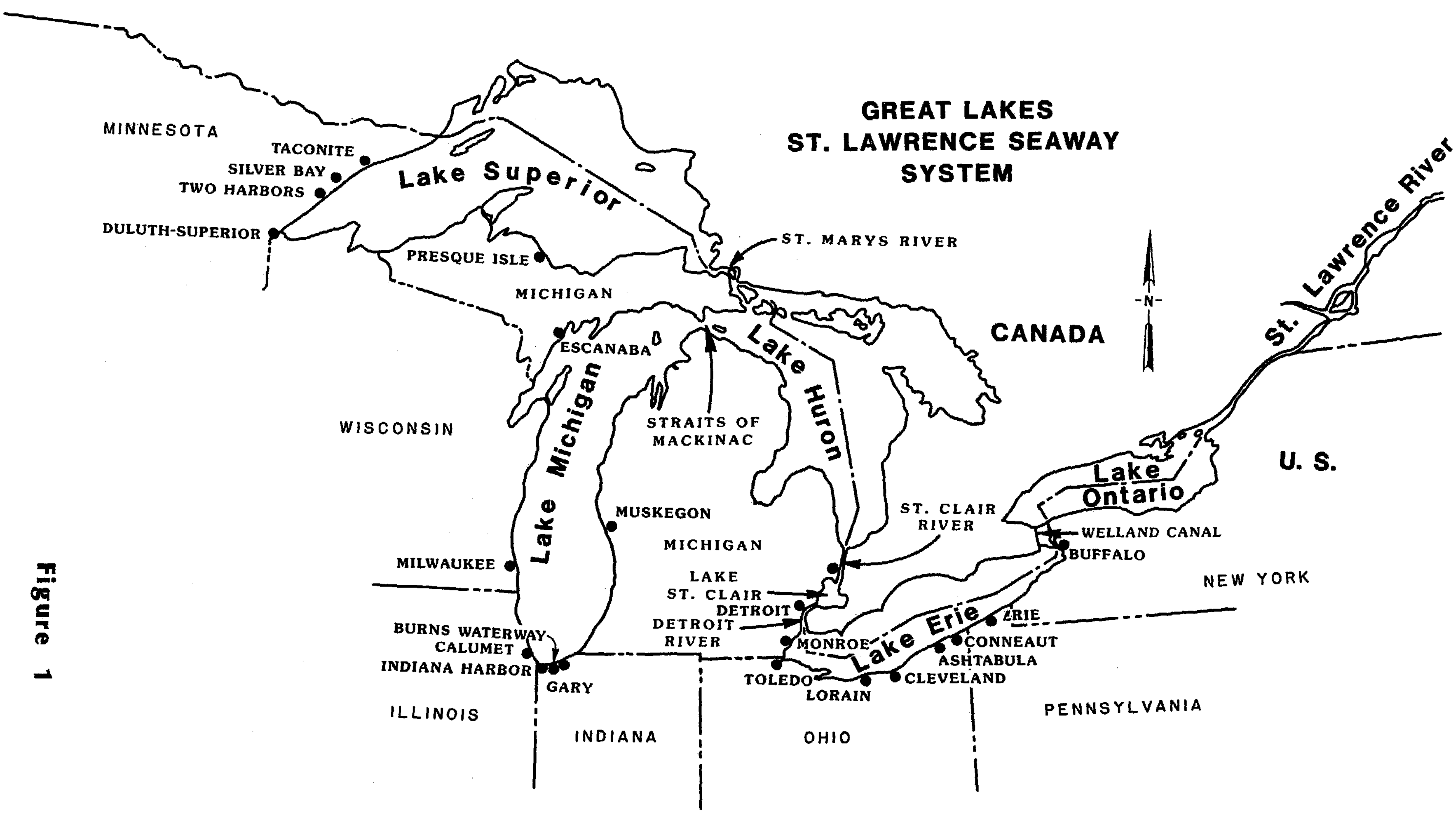
GREAT LAKES
ST. LAWRENCE SEAWAY
SYSTEM
MINNESOTA
TACONITE
SILVER BAY
TWO HARBORS
DULUTH-SUPERIOR
Lake Superior
PRESQUE ISLE
MICHIGAN
ST. MARYS RIVER
CANADA
N
St. Lawrence River
ESCANABA
Lake Michigan
Lake Huron
STRAITS OF MACKINAC
WISCONSIN
Lake Ontario
U. S.
MUSKEGON
MICHIGAN
ST. CLAIR RIVER
WELLAND CANAL
BUFFALO
MILWAUKEE
LAKE ST. CLAIR
DETROIT
DETROIT RIVER
NEW YORK
Lake Erie
ERIE
BURNS WATERWAY
CALUMET
INDIANA HARBOR
GARY
MONROE
CONNEAUT
ASHTABULA
TOLEDO
LORAIN
CLEVELAND
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA

Figure 1

Analysis to date has focused on the development and screening of alternative improvements to determine those that demonstrate potential economic feasibility, and the identification of significant impacts associated with people, the environment, and institutional considerations.

In analyzing potential additional system-wide improvements, the identification of the base condition for the existing system (channels, locks, and harbors) is extremely important. While a 27-foot project depth (25.5 safe vessel draft) has been provided in all the connecting channels, many harbors, including some that handle millions of tons of commodities annually, do not have a 27-foot project depth. These harbors are not fully utilizing the capacity of the existing system.

This study has focused, therefore, on the harbors with an existing 27-foot project depth. These incude: Duluth-Superior, Minnesota-Wisconsin; Two Harbors, Silver Bay, and Taconite, Minnesota; Presque Isle, and Escanaba, Michigan (the 6 major U.S. taconite shipping harbors on the Great Lakes); Muskegon, Michigan; Burns Waterway, Gary, and Indiana Harbor, Indiana; Calumet, Indiana-Illinois; Milwaukee, Wisconsin; St. Clair, and Detroit, Michigan; Toledo, Lorain, Cleveland, Ashtabula, and Conneaut, Ohio; Erie, Pennsylvania; Monroe, Michigan; and Buffalo, New York. Monroe, Michigan, is proposed to have a 27-foot project depth based on an individual harbor study submitted in 1980. Also, studies of Buffalo and Cleveland Harbors are underway to determine the merits of deepening wider areas of these harbors to a 27-foot project depth. Trade between these 22 harbors, if accomplished through additional commercial navigation system modifications, could result in benefits which could immediately be "applied" against the system-wide costs of those modifications.

SECTION II

PROBLEM IDENTIFICATION

Understanding the diverse problems, needs and existing conditions associated with the Great Lakes commercial navigation system and the economic, social and institutional systems that interact with it establishes a guide to the formulation of alternatives that address these problems and needs. While many of the problems and needs listed below vary in intensity according to geographic areas, there are two primary issues that form the basis for problem analysis in this study. These are the needs that arise from the commercial fleets desire for economic optimization; and the potential impacts on the existing environmental, social and institutional systems that could result from those modifications necessary to meet the demands of the commercial fleet. The problems and needs of the various systems can best be summarized by major navigational feature.

COMMERCIAL NAVIGATION PROBLEMS

a. Capital investment required to accommodate larger vessels.
b. Maintenance costs.
c. Vessel size and its effect on transit of channels.
d. Safeguards to avoid spills of oil and other hazardous substances.
e. Navigation during fog and high winds.
f. Vessel traffic and speed control.
g. Impacts on historic and cultural resources.
h. Potential disruption of fish and wildlife habitat.
i. Operational training of vessel pilots.
j. Potential for shoreline and shore structure damage.
k. Availability of sites for dredge disposal.
l. Potential bottom scouring.
m. Secondary employment effects of structural and non-structural improvements for waterborne transportation.
n. Potential recreational boating effects and associated recreation activities in the channels.

o. Potential social effects on channel residents.
p. Canadian participation, responsibility, and cost sharing.

Harbor Problems

a. Ramifications of vessel size in relation to vessel handling and control.
b. Operation of loading and unloading facilities.
c. Capital investment of others needed to handle larger vessels.
d. Potential shoreline and shore structure damage.
e. Water quality, vessel waste discharge and turbidity.
f. Safeguards to avoid spills of oil and other hazardous substances.
g. Interfacing larger vessels with other transportation modes.
h. Adequate turning basins.
i. Potential bottom scouring.
j. Potential disruption of fish and wildlife habitat.
k. Potential air pollution.
l. First costs and the operation/maintenance costs of the modifications.
m. Potential effects on littoral transport, both on lakes and rivers.

Locks

a. Relationship between existing and potential vessel sizes and existing facilities.
b. Capital investment requirements for necessary facilities to support and handle larger vessels.
c. Traffic control and service requirements.
d. Effects and constraints of additional locks.
e. Maintenance costs for modifications.
f. Determination of maximum lock size.
g. Safeguards to avoid disruption of service from accidents in critical areas.

h. Need for additional locks.
i. Potential social effects of modified or new lockage systems.
j. Potential economic impacts resulting from lock modification.
k. Potential disruption of fish and wildlife habitat.
l. Requirements and contingency plans to handle hazardous material transport.
m. Lock crew safety.
n. Potential effects on employment.
o. Water quality, vessel waste discharge and turbidity.
p. Potential effects on recreational boating and associated activities.
q. Canadian participation and responsibility.
r. Potential air pollution.
s. Navigation during fog and high winds.

Associated Problems

a. Relationship of vessel size to system capacity.
b. Modifications for cargo handling by others.
c. Optimum vessel size that would be feasible.
d. The appropriateness of considering improvements to the upper Great Lakes without improvements to the Welland Canal - Lake Ontario - St. Lawrence River portion of the system.
e. Use of alternative modes of transportation in lieu of changes to the existing system (such as utilization of rail transportation between Marquette and Escanaba in lieu of alterations to the St. Marys River).
f. Current and projected origin and destination patterns.
g. Significance of an energy policy on commercial navigation.
h. Alternatives to increased capacity of the Great Lakes system.
i. Insurance costs due to larger vessels.
j. Correlation between viability of water transportation and the economic well-being of the Nation.
k. Stockpiling effects on the environment.

1. Potential overall impact of larger vessels on Great Lakes employment.

EXISTING CONDITIONS

A general survey of the Great Lakes-St. Lawrence Seaway System provides a benchmark against which potential impacts from proposed modifications to the existing commercial navigation system can be evaluated.

The region provides a good "quality of life" through its beautiful scenery, fishing, swimming, power boating and sailing, and through agriculture, mining, manufacturing, water and power supply, and transportation. All these activities are dependent upon the water resources of the system.

The Great Lakes System

The Great Lakes-St. Lawrence Seaway System extends from the western end of Lake Superior to the Gulf of St. Lawrence on the Atlantic Ocean, a distance of more than 2,000 miles. The five Great Lakes -- Superior, Michigan, Huron, Erie and Ontario -- with their connecting channels and Lake St. Clair, have a water surface area of about 95,000 square miles. The lakes lie partly in each of the two countries of Canada and the United States except for Lake Michigan which lies wholly within the United States. The total area of the Great Lakes basin, both land and water, above the eastern end of Lake Ontario is approximately 296,000 square miles, of which 174,000 square miles are in the United States and 122,000 square miles are in Canada. The Great Lakes and the connecting channels have a controlling commercial navigation depth of 27 feet. Characteristics of the five Great Lakes are as follows:

TABLE 1

GREAT LAKES CHARACTERISTICS

Great Lakes	Water Surface Area (sq. miles)	Length (miles)	Breadth (miles)	Maximum Depth (feet)	Drainage Area (sq. miles)
Lake Superior	31,700	350	160	1,333	81,000
Lake Huron	23,000	206	101	752	74,800
Lake Michigan	22,300	307	118	925	67,900
Lake Erie	9,900	241	57	212	33,500
Lake Ontario	7,600	193	53	804	34,800*

*Includes water surface area and tributary land area downstream to the St. Lawrence Power Plant at Cornwall, Ontario, Canada.

Hydraulics and Hydrology

Lake Superior has been regulated since 1921 by means of a series of control structures including a gated dam across the St. Marys River at Sault Ste. Marie, Michigan and Ontario. Construction of the gated dam was authorized by the International Joint Commission (IJC) as a condition to approval of the water diversion for hydropower. By operation of the gates, locks, and changes in power diversions, flows specified by the adopted plan of regulation can be achieved. The present plan of regulation is known as Plan 1977. Basically, the plan balances the levels of Lake Superior and Lakes Michigan-Huron to maintain their levels at the same position to each other according to their long-term monthly means, while protecting the maximum on Lake Superior. The plan of regulation is designed to meet criteria specified by the IJC which requires, among other things, that the control works be operated so that the mean level of Lake Superior would be retained within its normal range of stage such that the level shall not exceed elevation 602.0 feet IGLD (1955) or fall below elevation 598.4 feet IGLD (1955), and will be done in such a manner so as not to interfere with navigation. These actions have a small impact on the levels of Lakes Erie and Ontario in reducing levels when supplies are high.

Improved or further regulation of the Great Lakes system is being studied by two Study Boards. Their primary purpose is described as follows.

1. The International Lake Erie Regulation Study Board is an eight-member (four U.S. and four Canadian) technical Study Board appointed in accordance with a Reference from the two Governments to the International Joint Commission dated 21 February 1977. The Reference requested the commission to study the possibilities for limited regulation of Lake Erie. The Board's primary purpose is to conduct the study, taking into account the applicable Orders of Approval of the Commission and the recommendations of the Canada-Quebec study of flow regulation in the Montreal Region.

2. The International Great Lakes Diversions and Consumptive Uses Study Board is a ten member (five U.S. and five Canadian) technical Study Board appointed in accordance with a Reference from the two Governments to the International Joint Commission dated 21 February 1977. The Board's purpose is to assist the Commission in reporting to the Governments the effects of existing and proposed diversions within, into, and out of, the Great Lakes basin and the effects of existing and reasonably foreseeable patterns of consumptive uses on the Great Lakes water levels and outflows.

Lakes

Lake Superior is the largest of the upper Great Lakes. Compared with the other Great Lakes, its surface is more elevated above the Atlantic Ocean, is more irregular in outline, has deeper water, more fog, and less rain. The main United States commercial harbors are located at Duluth and Two Harbors, Minnesota; Superior and Ashland, Wisconsin; and Marquette and Presque Isle, Michigan. Two additional private harbors are located in Minnesota on the north shore of Lake Superior at Silver Bay and at Taconite Harbor. Each is used for the shipment of concentrated taconite-iron ore. In addition, there is an important Canadian harbor at Thunder Bay, Ontario.

Lakes Huron and Michigan are one lake from a navigation standpoint, since the Straits of Mackinac which connects the two lakes is so broad and deep there is no perceptible flow between them and their surfaces stand at the same elevation. Major harbors on Lake Huron located in the United States are at Calcite, Stoneport, Alpena, Alabaster, Bay City, and Saginaw. Major harbors on Lake Michigan are located at Port Inland, Escanaba, Muskegon, and Grand Haven, Michigan; Green Bay and Milwaukee, Wisconsin; Chicago and Calument Harbor, Illinois; and at Burns Waterway, Buffington, Gary, and Indiana Harbor, Indiana.

Lake Erie is the shallowest of all the Great Lakes and considerably smaller than Lakes Superior, Michigan and Huron. Major harbors on Lake Erie are located at Monroe, Michigan; Toledo, Sandusky, Huron, Lorain, Cleveland, Fairport, Ashtabula, and Conneaut, Ohio; Erie, Pennsylvania; and Buffalo, New York.

Lake Ontario is the smallest of the Great Lakes with its waters flowing into the St. Lawrence River to the Atlantic Ocean. It is connected to Lake Erie by the Welland Canal which extends for about 27 miles and provides a series of locks that overcome a difference in elevation of 326 feet. Major U.S. harbors on Lake Ontario are located at Rochester, Sodus Bay, and Oswego, New York. Major Canadian harbors are located at Hamilton and Toronto, Ontario. Investigation of facilities involving Lake Ontario and the International Section of the St. Lawrence River are being undertaken as part of the St. Lawrence Seaway Additional Locks Study.

Connecting Channels

St. Marys River is the outlet of Lake Superior and leaves the lake at Point Iroquois, flowing in a generally southeasterly direction through several channels to Lake Huron, a distance of from 63 to 75 miles according to the route traversed. The river drops approximately 22 feet with most of the drop (20 feet) occurring at the St. Marys Falls Canal, where four U.S. navigation locks and one Canadian lock allow for the transit of vessels. The natural control of the outflow from Lake Superior was a rock ledge at the head of the St. Marys River. This natural control has been replaced by the locks, compensating works, and powerhouses. As a result, the outflow from Lake Superior is regulated. Of particular interst in the St. Marys River are the Sugar, Lime, Neebish, and Drummond Islands which are inhabited year-round. Transportation to these islands is provided by ferry boat or tug during the summer. During the winter, transportation has traditionally been over the ice or by ferry boat through an established open water vessel track.

The St. Clair River-Lake St. Clair-Detroit River System connects Lake Huron and Lake Erie. The system is approximately 89 miles long and has a relatively uniform water surface profile with a fall of 8 feet from Lake Huron to Lake Erie. The St. Clair River has a length of about 39 miles. Lake St. Clair, extending between the mouth of the St. Clair River and the head of the Detroit River (a distance of about 18 miles) occupies a shallow basin having an average depth of about 10 feet, with low, marshy shores. The shallow depth requires a dredged commercial navigation channel 27.5 feet deep and 800 feet wide throughout its length. The Detroit River extends about 32 miles to Lake Erie. Major harbors located along the system are at Sarnia and Windsor, Ontario, and at Detroit, Michigan. There are no commercial harbors on Lake St. Clair.

The physical characteristics of the connecting channels are summarized below:

TABLE 2

CONNECTING CHANNELS CHARACTERISTICS

Connecting Channels	Length (miles)	Width (feet)	Depth (feet)	Fall (feet)
St. Marys River	63	300-1500	27-30	23
St. Clair River	40	700-1400	27-30	5
Lake St. Clair	18	700-800	27.5	0
Detroit River	31	300-1200	27.5-29.5	3

The connecting channels are unregulated (free flow) except for the St. Marys River which is controlled by a series of improvements. Although compensating dikes were constructed on the lower Detroit River to partially offset (hydraulically) the lowering of the water levels (due to past authorized navigational improvements in 1912, 1936, and 1962), the Detroit River is not considered regulated.

Locks

Locks in the Great Lakes-St. Lawrence Seaway System are located in the St. Marys River, Welland Canal and St. Lawrence River. In the St. Marys River at Sault Ste Marie, Michigan and Ontario, four parallel locks on the U.S. side, and one on the Canadian side are operational. The principal features of the locks in the St. Marys River (Soo Locks) are as follows.

TABLE 3

PRINCIPAL FEATURES OF THE ST. MARYS FALLS CANAL LOCKS

	Lock				
Principal Features	MacArthur	Sabin	Davis	Poe	Canadian
Opened to Commerce	1943	1919	1914	1969	1895
Width, feet	80	80	80	110	59
Length between mitre sill, feet	800	1350	1350	1200	900
Depth on upper mitre sill, feet	31	24.3	24.3	32	16.8
Depth on lower mitre sill, feet	31	23.1	23.1	32	16.8
Lift, feet	22	22	22	22	22

Harbors

There are presently 60 U.S. Federal deep-draft harbors on the Great Lakes that have received Federal assistance. The navigation depths at these harbors range from 16 feet to 28 feet. In addition, there are 15 U.S. private deep-draft harbors in the Great Lakes system. Harbors in the study area are listed in Table 4.

TABLE 4 -- U.S. GREAT LAKES FEDERAL AND PRIVATE HARBORS

Federal

Lake Superior

Grand Marais, Minn.
\+ Two Harbors, Minn.
\+ Duluth-Superior, Minn-Wis.
Ashland, Wisconsin
Ontonagon, Mich.
\+ Presque Isle, Mich.
Marquette, Mich.
Kewaunaw Waterway, Mich.

Lake Michigan

Menominee, Mich. & Wis.
Green Bay, Wis.
Sturgeon Bay, Wis.
Kewaunee, Wis.
Two Rivers, Wis.
Manitowoc, Wis.
Cheboygan, Wis.
Port Washington, Wis.
\+ Milwaukee, Wis.
Racine, Wis.
Kenosha, Wis.
Waukegan, Ill.
Chicago, Ill.
\+ Calumet Harbor, Ind. & Ill. & Lake Calumet
\+ Indiana Harbor, Ind.
\+ Burns Waterway, Ind.
Michigan City, Ind.
St. Joseph, Mich.
South Haven, Mich.
Holland, Mich.
Manistique, Mich.
Gladstone, Mich.

Lake Michigan (cont'd)

Grand Haven, Mich.
\+ Muskegon, Mich.
White Lake, Mich.
Ludington, Mich.
Manistee Harbor, Mich.
Frankfort, Mich.
Charlevoix, Mich.

Lake Huron

Alpena, Mich.
Cheboygan, Mich.
Saginaw, Mich.
Harbor Beach, Mich.

St. Clair/Detroit Rivers

Marysville, Mich.
\+ Port of Detroit, Mich. Detroit River
\+ St. Clair
Trenton Channel
\+ Monroe, Mich.

Lake Erie

\+ Toledo, Ohio
Sandusky, Ohio
Huron, Ohio
\+ Lorain, Ohio
\+ Cleveland, Ohio
Fairport, Ohio
\+ Ashtabula, Ohio
\+ Conneaut, Ohio

Lake Erie (cont'd)

\+ Erie, Pa.
\+ Port of Buffalo, N.Y.

Lake Ontario

Rochester, N.Y.
Great Sodus Bay, N.Y.
Oswego, N.Y.
Ogdensburg, N.Y.

Private

Lake Superior

\+ Taconite, Minn.
\+ Silver Bay, Minn.

Lake Michigan

Oak Creek, Wis.
Buffington, Ind.
\+ Gary, Ind.
Port Dolomite, Mich.
Port Inland, Mich.
\+ Escanaba, Mich.
Petoskey, Penn Dixie Harbor, Mich.

Lake Huron

Calcite, Mich.
Stoneport, Mich.
Port Gypsum, Mich.
Alabaster, Mich.
Drummond Island, Mich.

Lake Erie

Marblehead, Ohio

LEGEND

\+ 22 harbors reviewed in this report

SECTION III

FORMULATION OF ALTERNATIVE PLANS

Plan formulation is the development of combinations of management measures into alternative plans that exhibit technical feasibility and maximize contributions to the various planning objectives. Management measures are potential structural and non-structural modifications to the existing navigation system that address the problems and planning objectives of the study, but do not necessarily provide complete solutions individually.

MANAGEMENT MEASURES

Structural measures considered in this study include: construction of a new lock at the Soo; deepening the connecting channels and harbors to provide maximum draft; and constructing a canal between Lakes Superior and Michigan that would cross the Michigan Upper Peninsula. Non-structural measures would increase the operating efficiency of the existing lock system and include: traveling kevels, increased vessel speed entering the locks, decreased chambering time during locking, and increased traffic control.

NATIONAL AND REGIONAL PLANNING OBJECTIVES

The national objectives for planning water resources projects provides for the enhancement national economic development (NED) by increasing the value of the Nation's output of goods and services and improving national economic efficiency.

A set of planning objectives have been formulated based upon the water and related resource management problems, needs and opportunities identified for the Great Lakes region. The objectives listed below contribute to both the national and regional objectives for the economic life of the project.

a. Contribute to the development and efficient utilization of the Great Lakes/St. Lawrence Seaway commercial navigation system infrastructure;

b. Contribute to an increase in output of goods, services and external economics of the Great Lakes/St. Lawrence Seaway system;

c. Contribute to the maintenance of existing water levels and flows for the Great Lakes; and

d. Contribute to the quality of the Great Lakes/St. Lawrence Seaway environment, giving particular attention to the ecosystem and water quality of the lakes.

PLANS OF OTHERS

St. Lawrence Seaway N.Y. Feasibility Study for Additional Locks and Other Navigation Improvements.

A reconnaissance report for this study was prepared in May 1978 by the Buffalo District of the U.S. Army Corps of Engineers. The purpose of the study is to determine the adequacy of the existing locks and channels in the International Section of the St. Lawrence River in light of present and future needs, and the advisability of their rehabilitation, enlargement, or augmentation.

DEVELOPMENT OF ALTERNATIVE PLANS

The plan formulation process established several assumptions that formed the basis upon which the alternative plans were developed. These assumptions are:

- Alternative plans were formulated to provide system-wide compatability between the connecting channels and harbors study and the St. Lawrence River Additional Locks Study.

- The traffic forecasts would be developed on a system-wide basis.

- Benefits included in the analysis are based only on U.S. traffic.

- The costs included in the analysis are assumed to be 100% United States costs including harbors, channels and locks.

- Current two-way traffic patterns in the connecting channels would be maintained.

- Structural modifications considered would be designed to maintain existing water level profiles and flows.

- The maximum ship size considered in this analysis is 1200 feet by 130 feet.

With the use of the above study planning objectives and assumptions, several alternative plans were developed.

Plan A - The Without Project Plan

The without project plan is the Corps' best estimate of how the upper Great Lakes system would change over the 50 years of the project life assuming none of the structural or non-structural alternative plans under review were implemented. This plan forms a basis of comparison for further improvements (i.e., without a project vs. with a project). There are a number of economic, environmental and social considerations that go into the without project plan analysis.

Economic Considerations

The Corps has developed traffic forecasts on a system-side basis that estimate tonnage at the Soo Locks could increase to 150-185 million tons (short-tons) annually before a capacity constraint level was reached. Capacity is measured as a percent of lock utilization and represents the point at which vessel delay hours exceed potential transportation rate savings. Capacity has been defined in this study in the following manner:

Percent	Vessels in Queue/Lock	Delay Hours
90%	4	6+
80%	2	3-6
70%	1	up to 3

Based upon these parameters, the Welland Canal would approach a capacity condition sometime in the early 1990's. If the Canadian government took actions at that time to upgrade the Welland Canal and the U.S. locks on the St. Lawrence River were upgraded in a corresponding manner; then the Soo Locks would encounter an initial capacity condition sometime between the years 2000-2010. Once this capacity condition was reached, the Soo Locks would be operating at a maximum efficiency level and no further tonnage increases could be gained since vessel delay hours would outweigh transportation savings. If, conversely, no action was taken by the Canadian government to increase capacity at the Welland Canal, then the lower system would not expand beyond 80-85 million tons annually and the date for an initial capacity condition at the Soo would be moved further into the future.

Another economic consideration of the Great Lakes commercial navigation system anticipated to change over time, independent from any alternative plans being evaluated in this study, is the base condition of the navigation season. While 15 December is historically thought of as the closing date for operations at the Soo Locks, over the past 15 years the locks have continued in operation based on the demands of commerce many times. It is anticipated, therefore, that the base condition for the commercial navigation season during the project life would be:

Lock Node	Navigation Season
Soo Locks	1 Apr to 8 Jan ± 1 week (9-1/4 months)
Welland Canal	1 Apr to 31 Dec (9 months)
St. Lawrence	1 Apr to 15 Dec (8-1/2 months)

Although shipping companies consider stockpiling of general cargo uneconomical because of its relatively high value per ton, bulk commodities are often stockpiled during the winter because it is more economical to do so than shift to an alternative mode of transportation. This type of operation would be expected to continue.

It is anticipated that a limited increase in larger size vessels could occur in the future without modifications to the existing system. As more vessels of the 1,000-foot class are built, the total number of vessels in the Great Lakes fleet would be expected to reduce as the older, smaller vessels become obsolete. The existing Poe Lock or any future lock at the Soo Locks limits the design of future vessels traversing between Lake Superior and the lower lakes. Based upon current Federal regulation, the maximum size vessel that could be locked through the Poe Lock with special handling procedures is 1,100 feet x 105 feet.

Environmental Considerations

Many aspects of the Great Lakes environment are expected to show little or no change during the life of the project. Among these are climatic conditions, geology, and topography. There may be some changes in soil fertility resulting from weathering and agricultural practices. Other factors, such as air and water quality, are expected to gradually improve throughout the Great Lakes region over the next several decades assuming that current environmental protection laws are continued and enforced.

Human development along shorelines is expected to continue, but at a slower rate than the past due to enforcement of recent laws. If consumptive use of Great Lakes water results in a significant reduction in the levels of the lakes, some wetland areas will probably be shifted lakeward or lost completely. New wetlands or other valuable shoreline areas will be created in some locations as the result of the well-placed disposal of material from maintenance dredging and small scale navigation improvement projects. In other areas, local losses of shorelands and wetlands may result from such projects. Changes in bottom configurations at disposal sites or around new construction will alter habitat important to periphyton, benthic invertebrates, and fish. It is possible that such changes will significantly impact some local populations, but system-wide detrimental impacts are not expected.

Fish and wildlife of the Great Lakes Region would be expected to respond to management efforts as well as to the changes in the physical-chemical and biological environment outlined above. Wildlife in shoreline areas will probably increase slightly in undeveloped locations as the result of improved management techniques, but development of new areas will cause the displacement of many organisms. Fish and high quality benthic organisms are expected to return to areas which are currently too polluted for their use as water quality in these areas improves. Stocks of game and commercial fish will probably improve with tighter commercial fishing laws, reductions in lamprey populations, stocking of fish, and improved management techniques. Sought after sport fish will probably benefit most as management efforts will focus on these species.

Social Considerations

From 1966 to 1973, five of the metropolitan areas in the Great Lakes states with populations over one million actually lost manufacturing employment with only Minneapolis, Cincinnati, and Columbus showing absolute gains. Of the 165,200 manufacturing job gains in the region over the same seven year period, only 25,500 were in metropolitan areas; while 140,000 manufacturing jobs were realized in "exurban" areas. As cities lose manufacturing employment, they are required to provide public services at increasing costs; while, their local tax base deteriorates contributing to urban blight. But, the loss of plants for cities will not mean a long term gain for "exurban" areas.

Along with the decreasing opportunities is a diminishing standard of living for those who do receive income. Family income is, on the average, greater for the eight Great Lakes states than for either the Nation or Hinterland; however, family income is falling in the Great Lakes States and rising elsewhere. The number of families as well as family income increased by greater proportions in the Hinterland and Nation. Problems in the regional economy have led to diminishing population growth rates. Entire metropolitan areas, not just central cities, are losing people. Fifteen of the region's 58 SMSA's have had absolute population losses between 1970 and 1975. For the 1974-1975 period, the number of SMSA's with absolute population losses jumped to 26.

Similar losses have been projected for the basin. Per capita income in the basin has been from 10% to 20% above the national average during the period between 1950 and 1970. However, it is expected that the rate of growth in both personal and per capita income, following trends of population and employment, will decline relative to the Nation during the period from 1980 through 2020.

Plan B - Structural Alternative Plans

Four structural alternative plans were developed and reviewed for feasibility. These plans are:

1. System-wide channel and harbor modifications that provide maximum draft and vessel size on a system-wide basis.

2. Provide a new lock at the Soo Locks.

3. Deepen the upper St. Marys River and three Lake Superior commercial harbors to maximize draft during periods of high water on the lower system.

4. Develop an alternate canal across Michigan's Upper Peninsula.

Plan B-1 - System-Wide Channel and Harbor Modifications

The structural modification of the connecting channels and the 22 deep-draft harbors, including estimates of dredged quantities, disposal options and construction costs, has been analyzed. The analysis was performed at the survey level based on existing information and no new field studies were performed. Specific work items performed are:

- The modification of harbors, and channels, necessary to accommodate the existing fleet at new drafts from 26 feet to a maximum of 31 feet in one foot increments was analyzed. In addition, the incremental increases required to accommodate vessels 1100 by 105 feet, and 1200 by 130 feet at each draft for the connecting channels and all 22 harbors were also analyzed.

- Disposal options for dredge material were analyzed based upon information from the U.S. Fish and Wildlife Service on pollution levels in the harbors and channels. This approach was used to identify a range of disposal costs that could be anticipated once actual levels of polluted and non-polluted dredge quantities had been determined. In addition, environmental laws and regulations controlling disposal practices were identified.

- Alternative beneficial uses of dredge material have been identified where such uses appear practical.

- Alternative dredging and disposal unit costs were based upon available cost records for similar work efforts. Unit costs vary according to dredging methods, distances to disposal sites, disposal method, and disposal site land values. The unit costs and material quantities have been extended to total dredging costs for each harbor for various vessel sizes, drafts and pollution levels. The costs for relocation of utilities in the harbor and channel bed and private improvement costs have also been identified.

Estimate of Dredge Quantities

Criteria - Harbor and channel modifications were premised upon vessel design lengths, widths and drafts with a nominal bottom clearance of two feet for areas classified as overburden, and three feet for regions classified as rock. Depths to be dredged according to vessel draft in a rock or overburden area are listed in Table 5. Harbor and channel modifications necessary to accommodate vessels assume a one-way channel width 3.0 times the beam of the vessel and a two-way width 7.6 times the vessel beam. Table 6 lists the various widths in relation to vessel beam and width criteria.

TABLE 5

REQUIRED DEPTH ACCORDING TO VESSEL DRAFT
IN ROCK OR OVERBURDEN

Vessel Draft (feet)	Depth (feet)	
	Overburden	Rock
26	28	29
27	29	30
28*	30	31
29	31	32
30	32	33
31*	33	34
32	34	35
34	36	37
36	38	38

TABLE 6
WIDTH CRITERIA

Vessel Beam (feet)	Width (feet)	
	One-Way	Two-Way
105	315	798
130	390	988

*NOTE: Cost estimates on a system-wide basis were prepared for each one foot increment of additional draft, as shown in the table. A complete benefit/cost anslysis was accomplished for only the 28 foot and 30/31 foot system-wide draft, however, to cover what were judged to be the minimum and maximum increases in draft with a reasonable chance of feasibility. An effort to complete a system-wide deepening project to less than a 28 foot draft was judged to be proportionately even less effective than the 28 foot case, given the reduced level of benefits that would result.

Project Limits - New project limits were established in outer harbor areas and entrance channels extending from the harbor entrance to lake soundings sufficient for navigation when necessary. For some harbors, existing project limits extend into channels with critical curvatures which could create an obstruction in channel alignment and restricts passage of 1,200 foot vessels. Potential obstructions such as bridges, submarine cables, aerial cables, and ruins also occur in these channels which would incur relocation costs.

Disposal Site Selection

In identifying potential sites for the disposal of dredged material, Federal and State regulations controlling the disposal of dredged spoils were included in the identification criteria. The regulations were adhered to closely, however, site information was limited to mapping and literature searches, and not to actual site reconnaissance. Conflicts could arise in the utilization of potential disposal sites due to change of information which was not detailed in the available mapping and literature.

Plan B-2 - A New Lock at the Soo Locks

Locks were placed on the Great Lakes/St. Lawrence Seaway System to allow passage of vessels where the natural conditions of rapids and water falls made navigation impossible. The locks allow navigation through the waterways while maintaining relatively large differences in water level between the upstream and downstream sides of the lock.

Vessels using the lock facilities at the Soo Locks range from pleasure craft as small as 20 feet in length to ocean carriers 730 feet long, and lake carriers 1,000 feet long and 105 feet wide. The locking process varies depending on the type and size of the vessel, weather conditions and lockage demand, and upon the individual lock characteristics. However, the general locking process is always the same.

Factors Affecting the Locking Process - The time required to process a vessel through a lock (locking time) can be broken down into a number of components. An elementary breakdown of the three primary components is:

Entrance Time - Time from vessel arrival to vessel mooring inside the lock;

Chambering Time - Time required to close the rearward gate, empty or fill the lock, and open the forward gates;

Exit Time - Time from completion of chambering until the lock is ready to accept another vessel.

The length of the locking time is dependent upon individual lock characteristics, vessel characteristics, the preceding lock cycle, weather conditions, level of traffic, and equipment failures. Improper positioning of the vessels in queue can also cause delays.

The six alternative lock plans evaluated for increasing lock capacity at the Soo Locks are:

Vessel Size (feet x feet)	Lock Size (feet x feet)	Depth Over Sills 25.5 foot Draft	31 foot Draft
Up to 1000 x 105	1200x115	32 feet	36 feet
1100x115	1350x115*	"	"
1200x130	1460x145**	"	"

*A lock this size would replace the existing Davis Lock.

**A lock this size would replace the existing Sabin and Davis Locks.

Plan B-3 - Deepen the Upper St. Marys River and 3 Lake Superior Harbors

During periods of high water on the upper four Great Lakes, vessel owners often increase draft downstream from the Soo Locks to optimize operating efficiency. The effectiveness of this procedure is reduced, however, since the frequency of water levels below low water datum on Lake Superior is higher than for the other lakes. This precludes vessels from taking advantage of potential additional draft on Lake Superior, particularly during the early (April-May) portion of the navigation season.

Since Lake Superior is regulated, additional draft could be obtained through additional dredging. The alternative plan would consist, therefore, of deepening the upper St. Marys River from the Vidal Shoals Channel to the Brush Point Course in Lake Superior together with selected areas in Duluth/Superior, Two Harbors and Presque Isle Harbors an amount necessary to bring Lake Superior into a 50-50 control relationship with Lake Michigan-Huron. By performing this dredging, Lakes Superior and Michigan-Huron would have a more balanced relationship with one another and the additional draft could still be utilized up to 50% of the time during periods of low water on Lake Superior. While this alternative is a structural modification, it would be a method of optimizing the existing system rather than increasing capacity in the sense that the other alternatives do.

Plan B-4 - An Alternate Canal through the Michigan Upper Peninsula

This alternative was considered to provide a direct shipping route between Lake Superior and Lake Michigan. The present commercial shipping route between the two lakes is a relatively lengthy one. Vessels must currently utilize the St. Marys River and the Straits of Mackinac to travel between Lake Superior and Lake Michigan.

Two alternative canal routes were considered in the analysis. Both would cross the western section of the Upper Peninsula of Michigan and provide direct passage between Lake Michigan and Lake Superior. The benefits and costs were examined for canal depths of 28 to 33 feet in one foot increments for each route.

Plan C - Non-Structural Alternative Plan

The non-structural alternative plan could increase tonnage processed through the existing lock system without major structural modifications by increasing the efficiency of existing lock operation.

Four management measures were selected for consideration in the non-structural alternative. These are:

1. Install traveling kevels,
2. Increase ship speed entering the locks,
3. Decrease lock chambering time,
4. Improved lock traffic control system.

A range of locking time reductions was established for each measure based on operational experience. Engineering judgement was then used to determine a reasonable locking time reduction that could be obtained within this range. In addition to evaluating each non-structural measure individually, a combination of non-structural improvements to obtain maximum utility was also tested.

Traveling Kevels

Traveling kevels are wheeled movable mooring posts which would travel on a rail along the guide walls on both sides of the lock. Upon approaching the lock entrance, a ship would be moored to the kevels. The kevels would then tow the ship into the lock. A vessel under its own power must proceed into a lock very slowly to minimize the chance of damaging the lock or the vessel. Using traveling kevels a vessel could potentially move into a lock faster with the same degree of safety.

Increase Ship Speed Entering the Locks

Under this measure, vessels would be instructed to enter the locks at a higher rate of speed. Additional safety procedures and devices would be required at the lock to reduce potential lock and vessel damage. The vessel would have to rely to a greater extent than it presently does on the operation of its own controls, particularly the application of reversal of power. Additional safety devices could include replaceable fenders, energy absorbers, and rolling fenders. Some of these devices are currently in place at the Soo Locks and at the St. Lawrence River Locks.

Decrease Lock Chambering Time

Chambering time is the time required to close the rearward gate, empty or fill the lock, and open the forward gates. Locking time could be reduced by reducing the chamber dump/fill times and chamber exit times. To reduce the dump/fill time, the hydraulic system of the lock would require remodeling or replacement. The flow rate through the culverts and the intake and outlet ports would be increased. The valves would require modification to open and close faster. Exit times could be reduced by providing longitudinal hydraulic assistance for ships exiting downstream. Water would be allowed to enter the chamber through the filling ports from the upstream side to hydraulically assist the exit of downbound vessels. Implementation of this alternative would decrease the lock chambering times and thereby reduce the lock cycle time.

Improved Lock Traffic Control System

The proposed traffic control system would consist of a central, computer run control point for the lock system. Information concerning all of the vessels approaching or in the lock system would be input. The system would plan vessel arrivals at the lock to reduce lock approach times. Vessel meetings at restricted channel sections would also be planned to increase safety. Instructions would be relayed to the vessel captains by radio from lock traffic controllers at the central control station. The proposed traffic control system could be designed to reduce delays in lock approaches and would allow faster responses by the lock operators in the locking operations.

For the Soo Locks the improved lock traffic control system was determined to be the only effective plan of the four non-structural plans considered.

Plan D, Combination Structural/Non-Structural Alternative Plans

A fourth set of alternative plans have been analyzed which consist of combinations of the structural and non-structural alternatives described earlier to determine whether these alternatives were feasible on a system-wide basis. The combinations that were analyzed are portrayed in the following matrix - Table 7.

TABLE 7

COMBINATION STRUCTURAL/NON-STRUCTURAL ALTERNATIVES

ALTERNATIVE PLAN ('-feet)	LOCK UTILIZATION 1/ (Percent)	NAVIGATION SEASON 2/ (Months)	NON-STRUCTURAL CAPACITY INCREASE 3/ (Percent)	VESSEL DRAFT (Feet)	MAXIMUM VESSEL SIZE (feet x feet)
D - NEW POE SIZE LOCK & TRAFFIC CONTROL	80	9-1/4	4-1/2%	25.5	1000 X 105
D-1 NEW POE SIZE LOCK & TRAFFIC CONTROL + 28 FOOT DRAFT	"	"	"	28.0	"
D-2 NEW POE SIZE LOCK & TRAFFIC CONTROL + 31 FOOT DRAFT	"	"	"	31	"
D-3 DEEPEN UPPER ST. MARYS/LAKE SUPERIOR HARBORS + NON-STRUCTURAL	"	"			
D-4 INTRODUCTION OF 1100' VESSELS	"	"	"	25.5	1100 X 105
D-5 1100 FOOT VESSELS + 28 FOOT DRAFT	"	"	"	28.0	"
D-6 1100 FOOT VESSELS + 31 FOOT DRAFT	"	"	"	31.0	"
D-7 INTRODUCTION OF 1200 FOOT VESSELS	"	"	"	25.5	1200 X 130
D-8 1200 FOOT VESSELS + 28 FOOT DRAFT	"	"	"	28.0	"
D-9 1200 FOOT VESSELS + 30 FOOT DRAFT	"	"	"	30.0	"
SENSITIVITY TEST 1, NEW POE SIZE LOCK/ TRAFFIC CONTROL - 90%	90	"	"	25.5	1000 x 105
SENSITIVITY TEST 2, NEW POE SIZE LOCK/ TRAFFIC CONTROL+SEASON EXTENSION	80	10	"	"	"
SENSITIVITY TEST 3, NEW POE SIZE LOCK/ TRAFFIC CONTROL+CONSTRAINED WELLAND CANAL	"	9-1/4	"	"	"

1/ 80% - 4 vessels in queue/lock, 6+ hours delay
90% - 2 vessels in queue/lock, 3-6 hours delay

2/ 9-1/4 months - 1 April to 8 January ± 1 week
10 months - 1 April to 31 January ± 2 weeks

3/ 4.5% reduction in overall locking time (traffic control)

SECTION IV

ASSESSMENT AND EVALUATION OF PRELIMINARY PLANS

Assessment is the identification, description, and, if possible, measurement of the impacts of the alternative plans. These are the economic, social, or environmental consequences of an alternative which would be weighed during the decision-making process. Impact assessment requires forecasting where and when significant effects could result from implementing a given alternative. This determination requires analyzing monetary and nonmonetary changes based on professional and technical assessment of the resources.

Evaluation is the analysis of each alternative plan's potential impacts. Evaluation determines the subjective value of potential changes. This is accomplished by conducting "with project and without project" analysis of the alternative plans based on the changes identified in impact assessment and ascribing values to the impacts based on public input and the planner's judgment. The process begins by establishing the contributions of each alternative in relation to the planning objectives and then measuring those contributions according to four tests. These are:

a. Completeness - the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.

b. Effectiveness - the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.

c. Efficiency - the extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities.

d. Acceptability - the workability and viability of the alternative plan with respect to acceptance by the public and compatability with existing laws, regulations, and public policies.

ECONOMIC ANALYSIS

The economic analysis for preliminary feasibility studies consists primarily of:

1. Traffic forecasts by commodity group, using 1978 waterborne commerce statistics as the baseline and projecting traffic levels to the year 2050;

2. Transportation rate analysis, which compares alternative transportation modes (lake and ocean vessels, rail, barge, and truck) to determine the least expensive means of delivering bulk and general cargos within the Great Lakes region and for overseas trade;

3. Capacity analysis of the three lock systems on the Great Lakes and St. Lawrence, and in particular the Soo Locks, to determine points in time when constraints may develop and to test structural and non-structural measures for alleviating such constraints; and

4. Determination of national economic development (NED) benefits that could result from navigation system modifications over a 50 year project life.

Base data for the analysis were developed from work undertaken through contract by the consulting firms of Booz, Allen and Hamilton, Inc., of Bethesda, Maryland, and ARCTEC, Incorporated, of Columbia, Maryland.

The primary focus for economic evaluation in the preliminary feasibility studies has been to determine whether system modifications can be economically justified. These modifications could consist of deeper navigation channels, or an enlargement of the existing system so that vessels larger than what currently operate could be utilized. The various dimensions subjected to analysis have included vessel drafts of 26 to 31 feet and vessel sizes of 1100 and 1200 feet in length and 105 and 130 feet in width. A new large lock at the Soo to service only existing sized vessels has also been examined.

Quantification of benefits in this study is determined by: 1) reductions in the cost of waterborne commerce; or 2) measures to increase the capacity of a constrained navigation system in the future, so that commerce could continue to be serviced by water transportation instead of being forced to shift to more expensive transportation alternatives.

Three categories of transportation benefits have been separately classified. Vessel utilization savings measure the increased efficiencies of vessels taking advantage of greater system-wide channel and harbor depths. They also identify the reduction in shipping costs permitted by use of larger vessels on the system as a result of modifications of locks and channels. A plan formulation rationale has been developed for this stage of the study which requires that only those harbors taking full advantage of the existing maximum system draft or vessel size be included in the analysis of vessel utilization savings. There are 22 harbors considered to be qualifying under this standard, including harbors for which Corps of Engineers studies are underway and that presently recommend 27 foot harbor depths for use by the largest vessels on the system (e.g., Monroe Harbor). Other harbors would require modifications, either through provision of a greater depth to 27 feet, or longer dock facilities to handle the larger vessels on the system, before they would be considered to take full advantage of the existing navigation system.

Reduction of vessel delays at a lock when capacity conditions are reached constitutes a second benefit category. If structural or non-structural measures or policies can be implemented to allow an increase in tonnage able to be shipped through a lock per unit of time, or if a new lock can be constructed to service the increase in traffic, then reductions in vessel operating costs can be realized: vessels would no longer have to wait (or wait as long) in a queue.

The third benefit category is transportation rate savings. If a capacity constraint can be alleviated as a result of a modification to the navigation system, then additional amounts of tonnage can continue to be serviced by lake shipping. The most immediate alternative is for tonnage to be diverted to higher cost transportation modes for the commodities and routes under consideration. The benefit in this case is the difference between waterborne rates, with handling and transfer charges, if applicable, and the least cost alternative mode rate. The value of goods in transit, for general cargo and grain in particular, is also taken into account in determining an average rate differential. (The GL/SLS has an advantage in the grain trade, but a disadvantage in the general cargo trade, where faster alternative transportation service is frequently available).

Economic justification of the various alternatives analyzed is determined by comparing estimated average annual costs to estimated average annual benefits over a 50-year period of analysis. March 1982 price levels with a 7-5/8% interest rate were used in conducting the economic analysis.

PLAN A - THE WITHOUT PROJECT PLAN CONDITION

The without project plan condition, which assumes none of the proposed alternatives under review were implemented, forms the benchmark upon which potential impacts can be assessed and evaluated. This plan condition would be one in which the existing fleet, which includes Class 10 (1,000 feet x 105 feet) vessels, would continue to operate at the current safe vessel draft of 25.5 feet. The navigation season over time would probably be 9-1/4 months from 1 April to 8 January ± 1 week. Since no structural or non-structural plans would be implemented, capacity at the Soo Locks would be limited to 150-185 million tons annually depending upon the capacity measure (percent lock utilization) use, and would occur between the year 2000 and 2005. There would be no costs associated with this plan beyond the normal costs required for operation and maintenance activities.

Since one of the assumptions made during the plan formulation process was the existing locks would continue to operate throughout the life of the project, an estimate was made for costs associated with the major rehabilitation that would be required for each lock over this time period.

These costs would be in addition to normal operation and maintenance costs and are summarized below:

TABLE 8
SOO LOCKS REHABILITATION

Lock	Projected Year of Rehabilitation	Cost
Davis	1992	$62,500,000
Sabin	1992	62,500,000
MacArthur	2010	78,000,000
Poe	2045	87,600,000

From a Social/Institutional standpoint, to the extent that the project would contribute either to short-term, construction-related employment or to long-term employment opportunities through increased diversification of the employment base, those opportunities would be lost. In addition, as a capacity condition was approached at the Soo Locks, congestion on the connecting channels would increase as more transits were made to keep pace with the increased tonnage. This increased congestion would increase the opportunity for potential conflicts between commercial vessels and recreational craft.

Potential beneficial and adverse environmental impacts resulting from the alternative plans would not occur. Changes to the environment apart from this study as outlined earlier in the plan formulation section of the report, however, could be anticipated to occur.

The four evaluation tests of completeness, effectiveness, efficiency and acceptability are not applied to the without plan.

Two additional factors are to be evaluated concerning the Soo Locks, national defense and risk. The Great Lakes system has served the nation during periods of military conflict in the past, and would be expected to do so again in the future if the need arose. The Soo Locks are a vital link in the system. Also, there are presently 25 vessels in the existing fleet that are dedicated to the Poe Lock and can only use the Poe Lock for upbound and downbound transits. A breakdown in the Poe Lock could have serious consequences on bulk cargo movements on the Lakes. A risk analysis is proposed during the detailed study stage.

PLAN B - STRUCTURAL ALTERNATIVE PLANS

The structural alternative plans for increasing system capacity are: (1) increasing draft through additional dredging in harbors and channels first for the existing fleet and then for two larger vessel sizes; (2) construction of a new larger lock on the site of the Sabin/Davis Locks; (3) optimizing the existing system during periods of high water; and (4) providing an alternate canal through the Michigan Upper Peninsula. The first two structural alternative plans listed were tested with the lock capacity model to determine their potential effects on increasing capacity at the Soo. The other two were also analyzed as described below:

PLAN B-1 - SYSTEM-WIDE CHANNEL AND HARBOR MODIFICATIONS

A lock capacity model was utilized to determine the increased capacity that resulted from providing deeper drafts and larger vessels on the system. From this analysis two vessel drafts, 28 feet and 31 feet, were selected for full benefit/cost analysis. The results were:

TABLE 9

CAPACITY ANALYSIS-DEEPER DRAFTS

DEEPER DRAFTS (Feet)	CAPACITY INCREASE (YEARS) (due to deeper draft only)
EXISTING FLEET (up to 1000 feet by 105 feet)	
28	10
31	20
1100 feet x 105 feet	
28	7
31	14
1200 feet x 130 feet	
28	10
31	20

Costs for system-wide dredging of the connecting channels and selected harbors on the upper four lakes, using the existing fleet, ranged from $3.4 billion to provide a 28 foot draft to $5.34 billion to provide a 31 foot draft.

Since none of these alternatives was benefit/cost effective, they were eliminated from further consideration. Each of these plans was analyzed with an initial date of action in 1992, to maintain system-wide compatibility with plans under consideration in the Additional Locks Study for the Welland Canal and St. Lawrence River locks.

The significant environmental resources identified earlier for the study area could be influenced by the Great Lakes Connecting Channels and Harbors Project through the specific activities that would be carried out in the implementation and operation of the alternative plans. The proposed structural alternatives encompass four major types of activities; dredging, dredged material disposal, the building of structures, and vessel movement.

Dredging

Dredging activities related to a Connecting Channels and Harbors project are not expected to have significant impacts upon air quality at proposed navigation improvement sites. However, some very localized temporary negative impacts may occur as the result of equipment operation at the time of dredging.

Direct shoreland impacts of dredging will in most cases be limited to the nuisance collection of scum or debris dislodged from the bottom by dredging activities. In cases where channels are dredged through previous terrestrial areas or near to shorelines some loss of terrestrial habitat may occur, but such cases are unlikely.

Impacts on water quality and circulation represent a major concern in relation to dredging activities. Short-term direct effects of dredging on water quality may include: (1) the creation of turbidity and reduction in light penetration; (2) the resuspension of contaminated bottom material; (3) the release of nutrients and other materials trapped in the sediments, (4) the depletion of dissolved oxygen from the water column; and (5) the creation of floating scum and debris.

Most long-term impacts are related to modifications of bottom geometry in areas of dredging. Those effects may be positive or negative. Dredging may improve water quality by removing contaminated sediments from an area, thus decreasing toxic substance release and oxygen demand, or by improving circulation in restricted areas. However, dredging may also have long-term negative impacts by creating pools of stagnant water in areas of over dredging or by increasing the flushing time or polluted areas. Increased dredging in riverine areas where channels are bordered by wetlands may result in significantly decreased water flow through these important habitats. Impacts of such an action are difficult to predict but may significantly reduce wetland productivity.

Fish are probably subject to less direct effect by dredging than other aquatic organisms. Despite this, they may be injured by blasting, early life stages and small species may be entrained by dredging operations, and they are subject to gill irritation and stress induced by turbidity and toxic substances. Dredging operations may also harass fish. Hydrocarbons and other pollutants have the potential to interfere with olfactory senses affecting food location, escape from predators, selection of habitat, and sex attraction. The noise, physical presence of equipment, and changes in water quality associated with dredging may disrupt migration patterns, interfere with spawning, and result in the smothering of eggs and burial of spawning grounds. New dredging activities may result in removal of natural shelters including macrophyte beds and reefs. This would act to reduce the availability of spawning, feeding and nursery areas. All changes in species diversity and population size which occur at lower tropic levels will ultimately have some impact on fish and may ultimately decimate a fishery.

Mammals and birds would probably suffer no direct impacts as the result of dredging in aquatic areas although loss of habitat may occur when macrophyte beds are removed. In cases where terrestrial areas are to be converted into navigation channels, drastic impacts upon terrestrial fauna may occur. In addition to the obvious direct losses of habitat, navigation channels would alter local topography and block mammal migration routes. As discussed in relation to fish, any changes which occur at lower tropic levels will also ultimately affect birds and mammals of the area.

Dredged Material Disposal

Three types of disposal have been proposed for dredged materials; open water disposal, in-water confined disposal, and terrestrial confined disposal.

Open Water Disposal. The least expensive alternative, if a nearby site is available, is open water disposal. The impact of this type of disposal depends upon the disposal site, its bottom characteristics, and the characteristics of the dredged material. Open water disposal is currently restricted for polluted dredge spoils.

In-Water Confined Disposal. The impacts of confined disposal in aquatic habitats depends upon the material being deposited and the natural habitat present at the disposal site. If disposal facilities are constructed near to or adjoining shore, changes in shorelands will occur. A portion of the change will be the result of the direct addition of the new land the disposal facility creates. Additional shoreland changes may result from associated alterations in near shore currents which will affect littoral drift, sediment deposition, and erosion. The magnitude of these effects can only be judged on a site specific basis.

Terrestrial Confined Disposal. The impacts of terrestrial confined disposal depends upon the character of the spoil being deposited and the conditions of the site prior to disposal. Odors from sediments high in organic materials may contribute to local declines in air quality at disposal sites. Land use in the area will probably be changed significantly by the construction of a confinement facility. If sediments are highly polluted, future use of the area may be restricted to prevent introduction of toxic materials into the food chain. Sediment characteristics may also prevent future construction on the site.

Building of Structures

Implementation of the various alternatives of a Great Lakes Connecting Channels and Harbors Project would involve building a variety of major structures including locks, compensating works, breakwaters, confined disposal facilities, and docks. Construction of any of these structures may result in temporary declines in air quality associated with the operation of heavy equipment and creation of dust.

Breakwaters and in-water confined disposal facilities may affect shorelands by protecting these areas from the impact of open water wave action or by influencing littoral drift. The net result of this may be a change in erosion and deposition patterns along the shoreline.

Other impacts on shorelands are more directly related to human activities. Construction or improvement of dock facilities may result in increased development in harbor areas. Construction of in-water confined disposal facilities would result in additional terrestrial areas which may be developed or used as wildlife habitat. On-land confined facilities would alter the habitat at the site and may affect future use of the area.

During construction activities, building of all of the mentioned structures would have short-term impacts on local water quality. At worst, these impacts would be similar to those previously described for dredging as some excavation may be required. In most cases, water quality impacts would be less severe but of longer duration than those associated with dredging. Construction activities should not increase levels of nutrients or toxic materials in most cases but would probably increase turbidity. Even this effect should be relatively slight as construction activities deal mainly with the movement of rock.

Construction may cause changes in water flow patterns which can drastically affect the local aquatic environment. In the case of lock construction these changes would be largely short-term, lasting only during the construction phase. Dock construction or improvement would generally occur in areas of little water circulation and, in general, effects would probably not be of significance. Confined disposal facilities may have significant long-term impacts. As discussed in previous sections, these impacts may be beneficial or detrimental depending on local conditions. Disposal facilities may divert currents causing increased erosion or creating areas of reduced water exchange where pollutants may be concentrated. Such facilities may also be placed to protect sensitive areas from strong wave action and erosion damage.

Breakwaters and compensating works are designed to alter water flow patterns. Breakwaters are usually associated with harbor facilities. Their major impact on flow patterns often involves disruption of littoral drift patterns and reduction of water exchange between the harbor and surrounding waters. Compensating works are designed to reduce the discharge of rivers in order to prevent changes in water levels. Fixed compensating works, as evaluated in the project, result in areas of dead water immediately downstream of the structures. The habitat in these areas can be changed by such alterations in flow patterns.

Building structures can result in changes in local macrophyte and periphyton populations through changes in water quality, water flows, and available substrate. Productivity changes associated with water quality alterations have been extensively discussed elsewhere. New circulation patterns in an area may cause erosion or deposition of sediments, altering the suitability of the area for some species and resulting in changes in species composition.

Building structures would affect fish populations in a variety of ways. Fish inhabiting the area would be harassed by noise, vibrations and changes in water quality during construction activities. This may be limited to just chasing fish from the area for a short period or it may interfere with a critical life period such as spawning. In the latter case long-term losses to the population may result.

Wildlife and birds in the vicinity of new structures would also be harassed during construction but impacts would not often be significant. Increased development may result in obvious losses of wildlife habitat, particularly around dock and lock facilities. However, additional habitat may be created by other structures. Breakwaters are often used as resting sites by gulls and terns, and the quiet water areas created behind these structures are often used by waterfowl as resting and feeding areas. Similarly, compensating works may create areas of quiet water favored by some species of birds.

Operation of Larger Vessels

Some individuals and agencies have expressed concerns that the operation of larger vessels, in addition to the physical modifications they require, will damage the environment. Possible impacts of the operation of larger vessels include changes in air and water quality and their subsequent effects on the biota. It is assumed that larger vessels will consume more fuel and would emit more pollutants to the atmosphere. However, as large vessels are currently the most fuel efficient means of bulk commodity transport, a net decrease in atmospheric pollution would result from using larger vessels rather than alternative modes of transportation.

PLAN B-2 - A NEW LOCK AT THE SOO LOCKS

Three new lock sizes were tested with the lock capacity model to determine their effects. The results are summarized in Table 9 and once again, since the plan provided an incomplete solution, the installation of a new lock was reconsidered as part of a combination plan.

TABLE 10
CAPACITY ANALYSIS-NEW LOCK

ALTERNATIVE PLAN		CAPACITY INCREASE (YEARS)
Vessel Size (feet x feet)	Lock Size (feet x feet)	
1000 x 105	1200 x 115	28 - 30
1100 x 105	1350 x 115	28 - 30
1200 x 130	1460 x 145	28 - 30

Costs for a new lock ranged from $170 million for a lock 1200 feet by 115 feet, to $235 million for a lock 1460 feet by 145 feet with related harbor and channel improvements to accommodate the 1200 foot by 130 foot vessel size.

PLAN B-3 - DEEPEN THE UPPER ST. MARYS RIVER AND 3 LAKE SUPERIOR HARBORS

This alternative plan would increase the capacity/efficiency of the existing commercial navigation system by optimizing draft during periods of high water. In its current relationship, the frequency of water levels at or below low water datum on Lake Superior is higher than for the other lakes. This results in Lake Superior controlling draft 90% of the time even during periods of high water. The objective of this plan, therefore, is to determine the level of dredging necessary to bring Lake Superior into a 50%-50% relationship with Lakes Michigan/Huron and assure additional draft during periods of high water on the lower system. Through an analysis of 75 years of hydrologic data it was determined that with a 28-foot project depth in the upper St. Marys River from the Vidal Shoals area to Brush Point in Lake Superior and three Lake Superior commercial harbors, the objective could be met. Since Lake Superior is carefully regulated, the additional bottom clearance would enable vessel operators to anticipate a 26.5 foot draft from June through the balance of the navigation season. In addition, during the months of April and May which are the traditional low-water months, vessel operators could anticipate being able to take advantage of additional draft up to 50% of the time.

A review of the upper St. Marys River and the three deep-draft harbors on Lake Superior determined that additional modifications would be necessary to obtain a 28-foot project depth. These modifications included deepening the Vidal Shoals area on the upper St. Mary's to 29 feet to provide safe vessel clearance; 29 feet from Vidal Shoals to Brush Point; and deepening Duluth-Superior, Presque Isle and Two Harbors to 28 feet.

Total average annual costs associated with this plan are $11.5 million. Economic benefits resulting from the plan were estimated to be $10.0 million with a resulting B/C ratio of .90. Since this is an improvement to the existing system as opposed to additional improvements, capacity was increased by 2-3 years. The potential environmental, social and institutional impacts resulting from the implementation of the alternative would, on an order of magnitude, be the same as those outlined in the general dredging impacts discussion earlier. Since the costs associated with this plan are order of magnitude numbers, this plan is being recommended for further analysis in the next stage of the planning process.

PLAN B-4 - AN ALTERNATE CANAL THROUGH THE MICHIGAN UPPER PENINSULA

Two alternate canal routes were considered for this alternative. One route would consist of a canal between Au Train Bay on Lake Superior and Little Bay De Noc on Lake Michigan. The second route traverses the area of Michigan's Upper Peninsula between Munising on Lake Superior and Manistique on Lake Michigan.

While previous canal studies were designed to accommodate a 700 foot by 70 foot vessel, this study considered a 1,000 foot by 105 foot vessel. For each canal the 23.1 foot difference in elevation between Lake Superior and Lake Michigan would be overcome by three locks, each 1,400 feet by 160 feet, and located a minimum of one mile apart to be constructed in heavy fill sections which are difficult to breach under most conditions.

Route 1: Au Train - Little Bay De Noc

The Au Train - Little Bay De Noc alternative utilizes the natural courses of the Au Train and Whitefish Rivers which originate in the highlands approximately 13 miles south of the Lake Superior shore. The head of Little Bay De Noc is approximately 38 miles south of the mouth of the Au Train River in Au Train Bay. The surface profile along the centerline of this route rises sharply from Lake Superior level to an elevation of 760 feet approximately 7 miles south of Au Train Bay. This approximate elevation is maintained southward for about 12 miles.

From that point southward the land slopes more or less uniformly to the level of Little Bay De Noc on Lake Michigan. Rock at relatively shallow depths underlies the ground surface for most of the route except for the extreme northern section.

The shoreline of Little Bay De Noc at the southern end of the canal is such that the locks could be dispersed in broad fill sections extending across the bay.

Route 2: Munising - Manistique

The Lake Superior terminus for this route would utilize Grand Island Harbor at Munising. The southern terminus would be on Lake Michigan near the Village of Thompson about 6 miles southwest of Manistique. The length of the canal would be 41 miles. The terrain along this route rises from the level of Lake Superior to an elevation of approximately 950 feet five miles southeast of Munising. The main body of water intercepted by the canal would be the Indian River, which empties into Indian Lake. Several other streams would also be affected and would require inlet structures.

The results of the analysis indicate that neither the Au Train - Little Bay De Noc nor the Munising - Manistique route can be justified based on estimated project costs and benefits. In both cases annual project costs greatly exceed benefits based on operating cost savings. The benefit/cost ratios for Au Train - Little Bay De Noc vary from .018 to .024 for channel depths from 28 to 33 feet. The benefit/cost ratios for Munising - Manistique vary from .010 to .014 over the same range of channel depths. These benefit/cost ratios are very low when compared to the normal benefit/cost ratio criteria that the ratio be in excess of 1.0 for the project to be considered economically beneficial. These results support the findings of previous investigations.

PLAN C - NON-STRUCTURAL ALTERNATIVE PLAN

Although four management measures were originally included in the formulation of the non-structural plan, the lock capacity model simulation results, together with operational constraints on implementation, have eliminated three of these measures from further analysis.

The installation of traveling kevels, the mechanical devices that could move vessels into the lock chamber at a faster rate of speed with safety levels comparable to existing operations, has been eliminated. The configuration of the existing guide walls at the Soo Locks would make implementation of this measure operationally infeasible for three reasons. First, the guide walls along the approach channel and lock chamber are stepped which precludes the kevels from moving along a single track. Two kevels and track, with an interim movement by the linehandlers, would be required to operationalize this measure which would cause an increase in locking time. Secondly, the guide walls contain a series of conduits, tunnels and other improvements which would make them unsuitable to serve as a foundation for kevels of the size required to assist 800 - 1000 foot vessels in the lock. Finally, the length of the guide walls from approach channel to lock chamber is too short to anticipate a decrease in lock entrance time could be achieved over a vessel moving under its own power.

Increasing vessel speed entering the lock chamber has also been eliminated from consideration. Currently at the Soo Locks, a vessel is allowed to enter the lock chamber while a second vessel waits in queue moored to the approach channel guide wall immediately behind. As the vessel entering the lock approaches the front gate, water is compressed around and under the vessel forcing it back past the stern. The force of this water under existing conditions is sufficient at times to pull the vessel waiting in queue away from the approach canal guide wall. An increase in vessel speed entering the locks could increase the potential for vessels waiting in queue actually being pulled off of the guide wall and increase the potential for damage to the vessels and the locks. A second consideration in eliminating this measure is a vessel master cannot be ordered to proceed into a lock at a prescribed rate of speed. The rate at which he enters the lock is an individual decision based upon the manuevering characteristics of his vessel and his experience in operation in confined areas.

The third management measure eliminated from further consideration is decreasing lock chambering time. Chambering time consists of several components, but the two components most sensitive to speed increases are chamber dump/fill times and chamber exiting times. Chamber dump/fill time would be decreased through remodeling or replacement of the hydraulic systems in the locks. The effort would include modification of the intake/discharge valves to increase capacity; the installation of self-cleaning vents on the valves; and hydraulic assistance to vessels exiting downstream by opening the upstream valves as the vessel exits. A review of the operational impacts of four parallel locks on one another in terms of eddys, cross-currents and turbulence and the reduction in safety that could occur precluded this measure from further analysis. In addition, it is unclear without further hydraulic analysis whether the St. Marys River could sustain the flows required to obtain the increased fill rates without adversely affecting the upstream vessels waiting in queue. The potential for bottoming loaded vessels waiting in queue could be increased through this measure.

Increased traffic control through the installation of a computer run control point for the lock system does appear to have utility as a non-structural capacity increasing measure.

Approach time constitutes approximately 20% of the total time required for the locking process. The proposed traffic control system could reduce vessel approach times by approximately 22%, and total locking time by 4.5%. Analysis of this management measure through the capacity model indicated a 4.5% reduction in overall locking time would result in a 4-5 year capacity increase for the system. Increased traffic control has been established, therefore, as the non-structural plan for the Soo Locks system.

Total average annual costs associated with the implementation of this plan are estimated to be $128,000 with benefits estimated at $35,866,000. The corresponding B/C ratio is 280.2 which makes this a highly feasible alternative.

Since the electronic equipment envisioned in this plan would be placed in existing buildings, no adverse environmental or social impacts have been identified. A beneficial effect to both environmental and social concerns is the reduction in potential accidents that could occur within the connecting channels in tight reaches. Vessels approaching one another would be monitored and potential points of conflict could be avoided. An institutional issue identified in the analysis of this alternative is to obtain true traffic control. An agreement would have to be made between vessel operators and the United States/Canadian governments regarding what authority; i.e., the Corps of Engineers or the Coast Guard, would be the designated authority having control of commercial traffic on the system.

To summarize the non-structural plan utilizying the four tests established for evaluation:

Completeness: the computer based traffic control system would be complete in that it represents all necessary investment to insure realization of the plan. The only additional investment beyond normal operation/maintenance that may be necessary would be if the technology in the computer hardware over time changes sufficiently that a change could be warranted.

Effectiveness: based upon the results of the capacity model simulation, the alternative appears to be highly effective within limits. While the non-structural plan does not resolve the capacity problem for the 50 year period, it does appear to have good potential as a solution when used in combination with other alternatives.

Efficiency: while increased traffic control only poses a 4-5 year solution to the capacity problem, it is a highly cost efficient alternative with a B/C ratio of 280.2.

Acceptability: it appears the implementation of this alternative would be highly acceptable to all concerns assuming the issue of authority for traffic control can be agreed upon.

PLAN D - COMBINATION STRUCTURAL/NON-STRUCTURAL ALTERNATIVE PLANS

Ten combinations of structural and non-structural alternative plans were developed for analysis as portrayed in Table 7. Six data bases were utilized to determine whether feasible solutions were possible. These data bases are: traffic forecasts based upon two rates of growth; the capacity of the lock system (measured as a percent utilization); the length of the commercial navigation season; the capacity increase obtained through implementation of the non-structural plan (measured in years); maximum draft available to the fleet; and the maximum vessel size operating on the system. Plans D - New Poe-Size Lock and Traffic Control, and D-3 - Deepen the Upper St. Marys River and the Lake Superior Harbors, were reviewed in detail. The other eight plans were reviewed only in terms of the four evaluative tests of completeness, effectiveness, efficiency and acceptability, since they do not exhibit feasibility. In addition, three combinations were included for sensitivity testing. The same data bases were used and the combination reviewed in terms of the four evaluative tests.

The results of the benefit-to-cost analysis and evaluative tests for each of the plans are displayed in Table 11.

PLAN D - NEW POE SIZE LOCK + TRAFFIC CONTROL

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season from 1 April to 8 January ± 1 week, a 4-1/2% capacity increase from the non-structural alternative, a maximum available draft system-wide of 25.5 feet and the maximum vessel size in the fleet is 1000 feet x 105 feet.

Analysis of this alternative plan through the lock capacity model resulted in an initial capacity condition in the year 2004 when total tonnage reached 170 million tons annually. The capacity constraint was eased through the implementation of traffic control and then the construction of a new Poe size lock (1200 feet by 115 feet).

From an environmental standpoint, while this alternative does not have the potential to greatly improve the environment, it may provide some measure of enhancement or protection to the aquatic environment while still improving the navigation system. Although some short-term adverse impacts could result, the area around the locks is highly developed and direct long-term impacts are expected to be negligible. Possible long-term benefits may accrue to both environmental and social considerations through the reduction of congestion around the locks and a decrease in potential accidents or conflicts between commercial vessels and recreational craft. The institutional issues to be addressed if this alternative were implemented would include the cost sharing between the public and private sectors for construction and the establishment of a new flow regime between the United States and Canada to cover the increased flows required to service the new lock.

PLAN D-1 - NEW POE SIZE LOCK + TRAFFIC CONTROL + 28 FOOT DRAFT SYSTEM-WIDE

Plan D-1 combines Plan D with a 28-foot draft system-wide to accommodate the existing fleet.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season, a 4-1/2% capacity increase from the non-structural alternative, a maximum available draft system-wide of 28 feet and the maximum vessel size in the fleet is 1000 feet x 105 feet. Actions were taken in 1992 to increase system-wide capacity. These actions included a new Poe size lock at the site of the Davis Lock and system-wide draft increased to 28 feet.

PLAN D-2 - NEW POE SIZE LOCK + TRAFFIC CONTROL + 31 FOOT DRAFT SYSTEM-WIDE.

Utilizing Plan D, this plan would combine it with a 31 foot draft system-wide to accommodate the existing fleet.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season, a 4-1/2% capacity increase from the non-structural alternative, a maximum available draft system-wide of 31 feet and the maximum vessel size in the fleet is 1000 feet x 105 feet. Actions were taken in 1992 to increase system wide capacity. These actions included a new Poe-size lock at the site of the Davis, and a system-wide draft increase to 31 feet.

PLAN D-3 - DEEPEN UPPER ST. MARYS RIVER AND 3 LAKE SUPERIOR HARBORS + TRAFFIC CONTROL

This plan would consist of traffic control at the Soo Locks and deepening by one foot the upper St. Marys River from the Vidal Shoals Channel to the Brush Point Course in Lake Superior along with selected areas in Duluth/Superior, Two Harbors, and Presque Isle harbors. This would bring Lake Superior into a 50-50 balance with Lakes Michigan/Huron instead of the 90-10 condition which currently exists. Although this alternative would optimize the existing upper lakes commercial navigation system during periods of high water, the additional draft could be utilized up to 50% of the time during periods of low water on Lake Superior. This would accommodate the existing fleet.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season, a 4-1/2% capacity increase from the non-structural alternative, and the maximum vessel size in the fleet is 1000 feet by 105 feet.

PLAN D-4 - INTRODUCTION OF 1100 FOOT VESSELS ON SYSTEM.

In this plan the maximum available draft system-wide would remain 25.5 feet; however, the replacement lock at the Soo Locks would be 1350 feet by 115 feet and this would accommodate vessels up to 1100 feet by 105 feet.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season, a 4-1/2% capacity increase from the non-structural alternative, a maximum available draft system-wide of 25.5 feet and the maximum vessel size in the fleet is 1100 feet by 105 feet.

PLAN D-5 - 1100 FOOT VESSELS + 28 FOOT DRAFT SYSTEM-WIDE.

This plan combines Plan D-4 with a 28 foot draft system-wide. The replacement lock at the Soo Locks would be 1350 feet by 115 feet and the maximum available draft system-wide would be 28 feet. This would accommodate vessels up to 1100 feet by 105 feet.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season, a 4-1/2% capacity increase from tne non-structural alternative, a maximum available draft system-wide of 28 feet and the maximum vessel size in the fleet is 1100 feet by 105 feet.

PLAN D-6 - 1100 FOOT VESSELS + 31 FOOT DRAFT SYSTEM-WIDE.

Same as Plan D-4 with a maximum available 31 foot draft system-wide, this plan would accommodate vessels 1100 feet by 105 feet.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season, a 4-1/2% capacity increase from the non-structural alternative, a maximum available draft system-wide of 31 feet and the maximum vessel size in the fleet is 1100 feet by 105 feet.

PLAN D-7 - INTRODUCTION OF 1200 FOOT VESSELS ON SYSTEM.

Although the maximum available draft system-wide would remain at 25.5 feet, the replacement lock at the Soo Locks would be 1460 feet by 145 feet. This would allow vessels of 1200 feet by 130 feet to utilize the system.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season, a 4-1/2% capacity increase from tne non-structural alternative, a maximum available draft system-wide of 25.5 feet and the maximum vessel size in the fleet is 1200 feet by 130 feet.

PLAN D-8 - 1200 FOOT VESSELS + 28 FOOT DRAFT SYSTEM-WIDE.

In this plan the replacement lock at the Soo Locks would be 1460 feet by 145 feet combined with a 28 foot draft system-wide. This would accommodate vessels up to 1200 feet by 130 feet.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season, a 4-1/2% capacity increase from tne non-structural alternative, a maximum available draft system-wide of 28 feet and the maximum vessel size in the fleet is 1200 feet by 130 feet.

PLAN D-9 - 1200 FOOT VESSELS + 30 FOOT DRAFT SYSTEM-WIDE.

This plan combines Plan D-7 with a 30 foot draft system-wide to accommodate vessels up to 1200 feet by 130 feet.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season, a 4-1/2% capacity increase from tne non-structural alternative, a maximum available draft system-wide of 30 feet and the maximum vessel size in the fleet is 1200 feet by 130 feet.

SENSITIVITY TEST 1 - NEW POE SIZE LOCK + TRAFFIC CONTROL WITH 90% LOCK UTILIZATION.

For this sensitivity test, Plan D is implemented; however, utilization of the lock at capacity is increased to 90%. This would accommodate the existing fleet.

TABLE 11
LIST OF ALTERNATIVE COMBINATION PLANS

PLAN	Draft	Structural: Replacement Lock Size	Non-structural: Improvement Vessel Traffic Control	Initial Date of Action	(Non-Additive)	Average Annual Costs ($000)	Average Annual Benefits ($000)	B/C Ratio	Net Benefits ($000)
D	25.5'	1200' x 115'	4½%	2004	Non-Struc.	128	35,866	280.2	35,738
					Struc-Lock	15,849	86,500	5.46	70,651
					Lock + 7 Hbrs.	22,084	86,500	3.92	64,416
D1	28'	1200' x 115'	none	1992		285,162	207,909	.73	-
D2	31'	1200' x 115'	none	1992		438,561	238,174	.54	-
D3	Deepening upper St. Marys River plus 3 Lake Superior harbors			Anytime.	Current traffic	11,446	10,020	.88	-
					With traffic growth	11,446	12,664	1.11	1,218
D4	25.5'	1350' x 115'	none	1992		66,837	123,043	1.84	56,206
D5	28'	1350' x 115'	none	1992		292,453	204,039	.70	-
D6	31'	1350' x 115'	none	1992		446,086	234,136	.52	-
D7	25.5'	1460' x 145'	none	1992		105,127	118,769	1.13	13,642
D8	28'	1460' x 145'	none	1992		343,259	192,598	.56	-
D9	31'	1460' x 145'	none	1992		461,905	221,105	.48	-

For each plan except D-3, the following applied:

1. % lock utilization at capacity = 80%
2. Traffic forecast = Low: Developed specifically for GLCCH & SLSAL studies under contract by Booz Allen & Hamilton.
3. Length of season at the Soo = 9¼ months.
4. Constrained Welland Canal = No.

TABLE 11 (Cont.)

Four Evaluative Tests

PLAN	Completeness	Effectiveness	Efficiency	Acceptability
D	Cost estimates include on order of magnitude numbers all first costs related to construction both public and private as well as an estimate of annual O&M costs that would be required. To that extent, the plan is complete.	Based upon the results of the capacity model the combination of increased traffic control and a new Poe-size lock would provide a total of 32 years of additional capacity on the system. Therefore, it is effective, but would require additional analysis in the out-years to determine whether an additional lock would be required beyond the year 2036.	Most efficient of all alternatives analyzed in terms of dollars expended, benefits/capacity increases gained, environmental/social acceptability and institutional feasibility.	
D1	Cost estimates reflect all construction related first costs both public and private, and the annual O&M costs that would be required. Also includes all actions necessary to implement the plan.	Results in an addition to the capacity of the lock system out to the year 2042.	With a B/C ratio of .73, the plan is economically infeasible and has been eliminated from further consideration.	Potential adverse impacts from activities related to system-wide dredging make this plan less acceptable from an environmental/social impacts perspective.
D2	Same as for Plan D1.	Results in an addition to the capacity of the lock system out to the year 2042.	With a B/C ratio of .54, the plan is economically infeasible and has been eliminated from further consideration.	Same as for Plan D1.
D3	The objective of this plan is to optimize the existing upper lakes commercial navigation system during periods of high water and is therefore complete within the scope of that objective.	Dredging of one foot from the areas identified brings Lakes Superior into a 50-50 balance with Lake Michigan/Huron rather than the 90-10 condition that currently exists in terms of which lake controls at low water. The plan is effective since an additional foot of draft could be anticipated for 70-80% of the overall navigation season.	The B/C ratio is .88. A capacity increase of 2-3 years was obtained through this plan. Since the costs of dredging were at the survey level of detail, this alternative is recommended as a plan warranting further study.	Has some potentially adverse impacts since it involves some blasting in rock areas and in the three harbors. The environmental/social acceptability are to be analyzed in the next stage of study.
D4	Same as for Plan D1.	Results in an addition to the capacity of the lock system out to the year 2030.	B/C ratio is 1.84 and is economically feasible but has been eliminated from further study since the existing fleet with a new Poe-size lock maximizes annual costs and benefits.	Same as for Plan D1.
D5	Same as for Plan D1.	Results in an addition to the capacity of the lock system beyond the year 2042.	B/C ratio is .70 and is economically infeasible. Has been eliminated from further consideration.	Same as for Plan D1.
D6	Same as for Plan D1.	Results in an addition to the capacity of the lock system beyond the year 2042.	B/C ratio is .52 and is economically infeasible. Has been eliminated from further consideration.	Same as for Plan D1.
D7	Same as for Plan D1.	Results in an addition to the capacity of the lock system out to the year 2032.	B/C ratio is 1.13. Plan is economically feasible, but has been eliminated from further consideration since the Poe-size lock maximizes economic benefits to the system.	Same as for Plan D1.
D8	Same as for Plan D1.	Results in an addition to the capacity of the lock system out to the year 2040.	B/C ratio is .56 and is economically infeasible. Has been eliminated from further consideration.	Same as for Plan D1.
D9	Same as for Plan D1.	Results in an addition to the capacity of the lock system beyond the year 2042.	B/C ratio is .48 and is economically infeasible. Has been eliminated from further consideration.	Same as for Plan D1.

The assumptions under this plan are a 90% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season from 1 April to 8 January ± 1 week, a 4-1/2% capacity increase from the non-structural alternative, a maximum available draft system-wide of 25.5 feet and the maximum vessel size in the fleet is 1000 feet by 105 feet.

Testing of this combination plan through the lock capacity model resulted in an initial capacity condition in approximately the year 2012 when total tonnage reached 185 million tons annually. The capacity constraint was eased through the implementation of traffic control and then the construction of the new Poe size lock.

Total average annual costs associated with the implementation of this plan were estimated to be $22.1 million with average annual benefits from the two savings categories estimated at $82.3 million. The corresponding benefit-to-cost ratio is 3.7 which makes this an economically feasible alternative.

Utilizing the four evaluation tests, the alternative may be summarized as follows:

Completeness: Cost estimates prepared for this alternative include on order of magnitude numbers including all first costs related to construction both public and private as well as an estimate of annual operation and maintenance costs that would be required. To that extent, the plan is complete.

Effectiveness: Based upon the results of the lock capacity model simulation, the combination of increased traffic control and a new Poe size lock would provide a total of approximately 32 years of additional capacity on the system. It is, therefore, an effective alternative, but would require additional analysis in the out-years to determine whether an additional lock would be required beyond the year 2044.

Efficiency: While this alternative is as efficient as Plan D, operational constraints imposed by a 90% capacity condition and the reduction of safety levels that would result, preclude this alternative from further analysis. The operational constraints that make consideration of the 90% level infeasible as a capacity measure center on the assumption that downbound transits with four vessels waiting in queue up to 12 hours or an average six hours could be accomplished. The physical limitations of the St. Marys River above and below the locks, however, preclude the safe operation of vessels in such close proximity with that number of vessels in queue.

SENSITIVITY TEST 2 - NEW POE SIZE LOCK + TRAFFIC CONTROL WITH NAVIGATION SEASON EXTENSION.

This combination plan is Plan D with an extended navigation season of 10 months, to accommodate the existing fleet.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 10 month extended commercial navigation season from 1 April to 31 January, a 4-1/2% capacity increase from the non-structural alternative, a maximum available draft system-wide of 25.5 feet and the maximum vessel size in the fleet is 1000 feet by 105 feet.

Testing of this combination plan through the lock capacity model resulted in an initial capacity condition in approximately the year 2010 when total tonnage reached 182 million tons annually. The capacity constraint was eased through the implementation of traffic control and the construction of a new Poe size lock.

Average annual costs associated with the implementation of this plan were the same as Plan D as summarized in Table 11. None of the costs or benefits associated with the extension of the navigation season were incorporated into this analysis.

Utilizing the four evaluation tests, the alternative may be summarized as follows:

Completeness: Cost estimates prepared for this alternative include on order of magnitude numbers including all first costs related to construction both public and private as well as an estimate of annual operation and maintenance costs that would be required. To that extent, the plan is complete.

Effectiveness: Based upon the results of the lock capacity model simulation, the combination of increased traffic control and a new Poe size lock would provide a total of 34 years of additional capacity on the system. It is, therefore, an effective alternative, but would require additional analysis in the out-years to determine whether an additional lock would be required beyond the year 2044.

Efficiency: This alternative is as efficient as Plan D, but was run as a sensitivity test only. The plan has been precluded from further analysis since implementation of an extended season is beyond the scope of this study, and is being reviewed under separate authority.

SENSITIVITY TEST 3 - NEW POE SIZE LOCK + TRAFFIC CONTROL WITH A CONSTRAINED WELLAND CANAL.

This test combined Plan D with a constrained condition at the Welland Canal in 1992. A constrained Welland Canal would limit the tonnage serviced. This plan would accommodate the existing fleet.

The assumptions under this plan are an 80% capacity condition at the Soo Locks, a 9-1/4 month commercial navigation season from 1 April to 8 January ± 1 week, a 4-1/2% capacity increase from the non-structural alternative, a maximum available draft system-wide of 25.5 feet and the maximum vessel size in the fleet is 1000 feet by 105 feet.

Testing of this combination plan through the lock capacity model resulted in an initial capacity condition in approximately the year 2006 when total tonnage reached 170 million tons annually. The capacity constraint was eased through the implementation of traffic control and then the construction of a new Poe size lock.

Average annual costs associated with the implementation of this plan are $22,084 and average annual benefits from the three savings categories are $86,797. The corresponding benefit-to-cost ratio is 3.9 which makes this an economically feasible alternative.

Utilizing the four evaluation tests, the alternative may be summarized as follows:

Completeness: Cost estimates prepared for this alternative include on order of magnitude numbers including all first costs related to construction both public and private as well as an estimate of annual operation and maintenance costs that would be required. To that extent, the plan is complete.

Effectiveness: Based upon the results of the lock capacity model simulation, the combination of increased traffic control and a new Poe size lock would provide a total of approximately 36 years of additional capacity on the system. It is, therefore, an effective alternative, but would require additional analysis in the out-years to determine whether an additional lock would be required beyond the year 2042.

Efficiency: This alternative was conducted as a sensitivity test.

PLANS ELIMINATED FROM FURTHER CONSIDERATION

Through the assessment and evaluation process the following plans have been eliminated from further analysis because they are economically infeasible, incomplete in terms of effectiveness and/or unacceptable because of potential adverse environmental and social impacts:

PLAN B: STRUCTURAL ALTERNATIVE PLANS

1. PLAN B-1 - SYSTEM-WIDE CHANNEL AND HARBOR MODIFICATIONS

VESSEL (feet x feet)	DRAFT (feet)
Existing Fleet: (up to 100 x 105)	28 - 31
1100 x 105 :	25.5 - 28 - 31
1200 x 130 :	25.5 - 28 - 30

2. PLAN B-2 - A NEW LOCK AT THE SOO LOCKS

LOCK SIZE (feet x feet)	DEPTH OVER SILLS (feet)
Poe Size:	36
1350 x 115 :	32 - 36
1460 x 145 :	32 - 36

3. PLAN B-4 - ALTERNATE CANAL ACROSS THE MICHIGAN UPPER PENINSULA:

PLAN D: COMBINATION STRUCTURAL/NON-STRUCTURAL ALTERNATIVE PLANS

Plan D-1 - NEW POE SIZE LOCK + TRAFFIC CONTROL + 28 FOOT DRAFT SYSTEM-WIDE

Plan D-2 - NEW POE SIZE LOCK + TRAFFIC CONTROL + 31 FOOT DRAFT SYSTEM-WIDE

Plan D-4 - INTRODUCTION OF 1100 FOOT VESSELS ON SYSTEM

Plan D-5 - 1100 FOOT VESSELS + 28 FOOT DRAFT SYSTEM-WIDE

Plan D-6 - 1100 FOOT VESSELS + 31 FOOT DRAFT SYSTEM-WIDE

Plan D-7 - INTRODUCTION OF 1200 FOOT VESSELS ON SYSTEM

Plan D-8 - 1200 FOOT VESSELS + 28 FOOT DRAFT SYSTEM-WIDE

Plan D-9 - 1200 FOOT VESSELS + 31 FOOT DRAFT SYSTEM-WIDE

SECTION V

COMPARISON OF PLANS

The previous section of this report assessed, evaluated and eliminated from further analysis those alternative plans that lacked economic feasibility and/or exhibited potential environmental, social or institutional impacts that would make them unacceptable. The plan that survived this assessment/evaluation process, Plan D - New Poe Size Lock and Traffic Control, can now be reviewed as a potential candidate National Economic Development plan. One additional plan, Plan D-3, Deepening the Upper St. Marys River and 3 Lake Superior Harbors, also warrants further study. In addition, after analysis of the harbors throughout the system, it became evident that several harbor pairings (ports of origin and destination) on Lake Michigan may warrant improvement and be developed as a separate plan. Also, seven harbors which provide an existing 25.5 foot vessel draft may warrant improvement to accommodate Class 10 (1000 foot by 105 foot) vessels and could be considered an additional plan.

RATIONALE FOR CANDIDATE NED PLAN

National Economic Development (NED) is defined as an increase in the value of the Nation's output of goods and services and the improvement of national economic efficiency attributable to a project. It is determined by comparing the average annual benefits resulting from project implementation against the average annual costs of undertaking the project. The NED plan, therefore, is that plan which maximizes the excess of average annual benefits over average annual costs. Among all of the alternatives considered in a study, designation of the NED plan is that plan that maximizes net benefits. The basic economic benefits from navigation management and development plans are the reduction in the value of resources required to transport commodities and the increase in the value of output for goods and services. Specific transportation savings may result from the use of larger vessels, more efficient use of large vessels, more efficient use of existing vessels, reductions in transit time, lower cargo handling and tug assistance costs, reduced interest and storage costs, such as from an extended navigation season, and the use of water transportation rather than an alternative land mode.

CANDIDATE PLAN

A candidate plan is one which exhibits maximum economic feasibility and warrants further detailed analysis during the detailed study stage of the planning process. In this study, the plan which maximizes the excess of average annual benefits over average annual costs as required for the NED plan is Plan D -- New Poe Size Lock and Traffic Control, which assumes 80% lock utilization, a 9-1/4 month commercial navigation season, a 4-1/2% capacity increase through improved traffic control, a maximum draft of 25.5 feet, and a maximum vessel size on the system of 1000 feet x 105 feet. The analysis of the alternatives also revealed that, although none of the proposed alternatives have the potential to greatly improve the environment, Plan D does appear to offer some measure of enhancement and protection to the aquatic environment while still improving the navigation system. While this plan could result in negative short-term effects, the area is highly developed and direct long-term impacts, if experienced, would be negligible. The candidate plan for both the NED objective, therefore, is Plan D.

Rationale For Plans Warranting Further Study

In addition to the candidate plan, three additional alternatives exhibit sufficient feasibility that additional analysis should be conducted. These are Plan D-3, Deepen Upper St. Marys River and 3 Lake Superior Harbors + Traffic Control; An Analysis of Incremental Improvements on a Port-to-Port Basis to determine whether the existing system could sustain additional modifications that would optimize harbor pairings; and possible improvement to seven harbors to accommodate Class 10 vessels.

Cost Apportionment

Plans D and D-5, provide benefits to commercial navigation, therefore, under existing regulations the costs associated with dredging of the channels and transporting the dredged materials to disposal facilities would be borne by the Federal Government. Those costs associated with construction of confined disposal sites, including providing lands, easements, and rights-of-way, would be borne by the local sponsors.

However, on 15 July 1981, the Department of the Army, on behalf of the Administration, transmitted proposed legislation to Congress that would provide for full recovery of certain operation, maintenance and construction or rehabilitation costs for deep-draft channels and ports with authorized depths greater than 14 feet. If this legislation is enacted, Corps of Engineers expenditures for a project would be subject to recovery as provided in the proposed legislation. Accordingly, non-Federal interests would be required to reimburse the Federal government for construction of navigation features of the recommended plan, and all subsequent expenditures for operation, maintenance and rehabilitation; except for expenditures assigned by the Secretary of the Army to governmental vessels in non-commercial service. The proposal to fully recover these costs would supersede the previous requirement for a 5% State cash contribution.

The entire amount of the Federal construction or rehabilitation expenditures to be reimbursed, including interest during construction and interest on the unpaid balance, would be reimbursed within the life of the project, but in no event would exceed fifty years after the date the project becomes available for use. The interest rate for reimbursement purposes would be determined by the Secretary of the Treasury based on the average market yields on outstanding obligations of the United States.

SECTION VI

SUMMARY AND CONCLUSIONS

SUMMARY

The planning process to date has three primary objectives. These are: the formulation and analysis of preliminary alternative plans that address the problems and needs identified; determine those candidate plans which display feasibility; and determine whether there is sufficient overall feasibility, Federal interest, and local support to warrant further detailed study.

The Great Lakes Connecting Channels and Harbors Study has determined there are significant problems and needs related to the existing commercial navigation system and the economic, environmental, social and institutional systems that it interacts with. A series of structural and non-structural alternative plans for system improvements have been formulated and reviewed for overall feasibility. The conclusions of this analysis are:

Engineering

- Lock, connecting channel, and harbor improvements are engineeringly feasible.

- Cost estimates include all U.S. costs for U.S. harbors, and for a lock at Sault Ste. Marie, Michigan, and the connecting channels in U.S. and Canadian waters (i.e., St. Marys River, St. Clair River - Lake St. Clair - Detroit River system).

Economic

- Capacity of the Soo Locks has been determined to be most significantly affected by: traffic to be served; lock utilization; the length of navigation season; and the development and characteristics of the fleet mix.

- The need and justification for improvements at the Soo Locks are supported both dependent and independent of developments at the Welland Canal and St. Lawrence River system.

- Combinations of existing or larger lock sizes with deeper drafts on a system-wide basis are not economically justified at this time.

Environmental

- Two areas of potential impact associated with structural modifications are:

1. Dredging new areas associated with improvements such as channel widening and enlargement of turning basins.

2. The disposal of dredged materials either in confined disposal facilities or open lake disposal.

- Alternatives which reduce congestion in the upper St. Marys River have potential for environmental benefits.

Hydraulics and Hydrology

- To offset any additional deepening, compensation would be required in the St. Marys, St. Clair and Detroit Rivers to maintain existing water surface profiles. Compensation beyond a 34-foot project depth for the St. Marys River would require regulatory structures or locks.

- Replacement of the existing locks with a new larger lock could affect flow available for hydropower generation.

- Lakes Superior and Michigan/Huron can be brought into a more balanced relationship by dredging one additional foot in the upper St. Marys River and the harbors of Duluth-Superior, Presque Isle and Two

Harbors. This dredging would permit optimization of the existing commercial navigation system on the upper Great Lakes by permitting a maximum draft of 26.5 feet during periods of high water.

<u>Social</u>

- Studies to date indicate there are no significant adverse social impacts that would occur from improvements to the Great Lakes commercial navigation system. There could be some minor adverse impacts on recreational boaters and fishermen during the construction period. However, this would be temporary. The socially beneficial impacts also would be significant during the construction period through the creation of jobs during this period, especially in the regions of high unemployment.

- The Great Lakes' State and Federal Governments, steel, iron ore, coal, utility, grain interests, and shipping companies and users would benefit directly from the project. The general public would benefit from the project as a result of reduced transportation costs (e.g., lower costs for coal shipments would mean lower utility costs).

- The project would contribute to long range improvements in overall employment in the water transportation shipping industry.

- The project would stimulate business and employment whose trades are impacted by commercial navigation system improvements.

<u>Institutional</u>

- Coordination to date with the Canadian agencies has been limited to a request for information and exchange of views. The final development of alternatives and proposed final recommendations, if any, will continue to be coordinated.

- During the final development of the alternatives, the policies of project cost sharing will be incorporated as applicable at that time consistent with Administration guidelines.

- Coordination with the eight Great Lakes States individually, and collectively with assistance from the Great Lakes Commission, will be continued through the final development of alternatives.

- The alternatives selected for detailed study reflect environmental/ social concerns expressed by special interest groups and the public through the public coordination process, such as on dredging alternatives. These concerns will be investigated in further detail during the final development of alternatives.

CONCLUSIONS

- A second large lock (Poe size - 1250 feet by 115 feet), together with increased traffic control, at Sault Ste. Marie, Michigan, to accommodate the existing and projected fleet at the existing 27-foot project depth is justified as a candidate NED plan, and detailed analysis is warranted.

- In addition to economic feasibility, there is justification for a second large lock at the Soo Locks on the basis of National Defense, and to reduce the risk of dependency of 25 vessels (Classes 7, 8, 9, & 10) of the existing fleet only on the continuous operation of the existing Poe Lock.

- Modifications of the system to obtain deeper drafts is economically and environmentally infeasible at this time.

- Three additional plans warrant detailed study for feasibility. These are:

  - deepening the upper St. Marys River and 3 Lake Superior harbors + traffic control;

- enlarging the seven deep-draft harbors on the upper system that do not currently service Class 10 (1000 feet by 105 feet) vessels;

- analyzing on a port-to-port basis deep-draft harbor pairs on Lake Michigan that could benefit from additional modifications beyond the existing 27-foot capacity system.

- While the final form for user-fees and full cost recovery policy for navigation improvements has yet to be determined, potential users/sponsors and affected States for the project support continuation of the detailed studies.

The study is continuing into the final detailed study stage of the planning process, and the Final Feasibility Report and Environmental Impact Statement are scheduled for completion in September 1985.